FEEDING ECOLOGY AND CONSERVATION OF THE GOLDEN LANGUR *TRACHYPITHECUS GEEI* KHAJURIA IN TRIPURA, NORTHEAST INDIA[1]

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(*With seven text-figures*)

Key words: Golden langur, *Trachypithecus geei*, Tripura, feeding, conservation

Feeding ecology of an introduced group of the golden langur (*Trachypithecus geei*) in Sepahijala Wildlife Sanctuary is discussed with special reference to its conservation in its new habitat. Data were collected using group-scan method. A total of 7,752 scans were made, feeding alone accounting for 3,530 scans (45.5%). Diurnal and seasonal variation in the time spent on feeding was not significant, but a very weak significant difference existed in the time spent on feeding in different months. A total of 53 food species, belonging to 10 families, were used by the golden langur, but only ten species accounted for about 57% of the feeding. Of the 28 families, ten accounted for almost 78% of the food. The three most intensively used food species were: *Ficus racemosa*, *Salmalia malabarica*, and *Adenanthera pavonina*. The golden langur shared food plants with *Trachypithecus phayrei* and *T. pileatus*, and with the local human population. The golden langur was mainly folivorous, spending most time feeding on young leaves (41.4%). The ability of the golden langur to survive on fast-growing exotic plantation species, to use food resources on the ground, and to share resources with other user groups, has helped it to survive in the wild. These qualities make the conservation of the golden langur feasible in its range, where shifting cultivation and plantations of exotic species are common.

Introduction

The golden langur, *Trachypithecus geei* Khajuria, discovered in 1956, is known to occur in India from the Sankosh basin in the west to Manas basin in the east, and from the Assam-Bhutan border foothills in the south, to the inner Himalayan range in the north. Earlier reports on the distribution of this species (Gee 1955, 1961; Khajuria 1956, 1962) describe its occurrence as confined to the Assam-Bhutan border in Jamduar-Raimona area, in Raimona Forest Range, Goalpara district, Assam. This species was first observed in the Bhutan part of Manas Sanctuary by Wayre (1968a, 1968b), and was later described from the Black Mountain Range in Central Bhutan (Mukherjee 1978, Mukherjee *et al.* 1993). Saha (1980) described the actual range of the golden langur only in India (Assam) and Bhutan and concluded that this is a Bhutanese species, and only a marginal part of its range lies within Indian territory between 150 and 3,000 m above msl. On October 6, 1996, members of the Association for Protection of Environment and Endangered Species spotted a few golden langur feeding on bamboo shoots in Sangsak Reserve Forest of Garo Hills, Meghalaya (The Asian Age, November 27, 1996).

Mukherjee and Saha (1974) counted 125 individuals in 13 groups (3 groups from Bhutan — one each from Panjurmane, Tama, and Gaylegphung; and 10 groups from Assam — 7 from Jamduar and 3 from Raimona). Saha (1980) counted about 1,250 in 67 groups from west, central, and east Bhutan provinces. More

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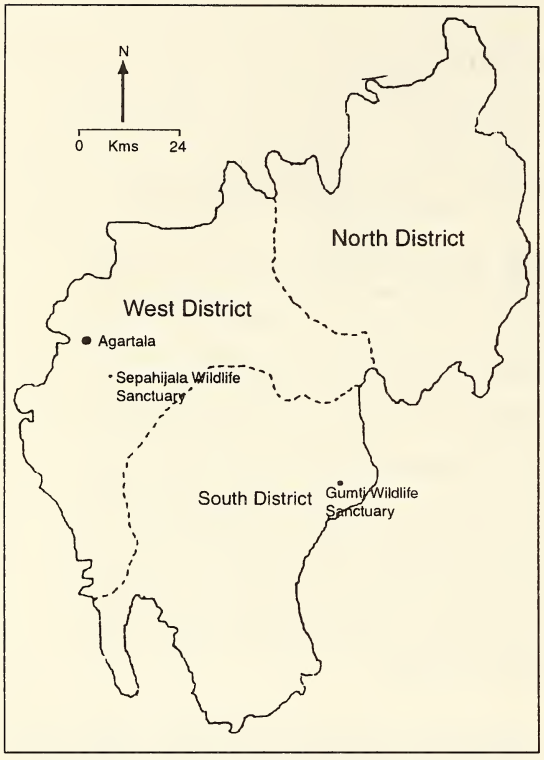

Fig. 1: Map of Tripura showing location of Sepahijala Wildlife Sanctuary

systematic surveys in all northeastern states may reveal a wider range in India. Mukherjee (1981) counted 355 individuals in 34 groups from Goalpara, Kamrup, and Dhubri districts in Assam. Mukherjee (1992) also noted that their number is less on the Indian side between east of Sankosh and west of Manas, and more abundant in the forests of central Bhutan. Wangchuk (1995) sighted a total of 127 individuals along a 39 km transect in Mangde Chu Valley of Central Bhutan, and estimated a population of 4,341 individuals (2.1/sq. km). He also noted the presence of Hanuman langurs in the territories of golden langurs in Tsirang area, and reported the possibility of their interbreeding.

Tripura does not lie in the distribution range of this species. Yet, taking advantage of the favourable habitat conditions, two captive groups of golden langur were released into the wild in 1988: one in Trishna Wildlife Sanctuary, south Tripura, and the other in Sepahijala Wildlife Sanctuary, (SWLS), west Tripura. The golden langur group in SWLS has survived and adapted to the wild (Gupta and Mukherjee 1994), where this species shares the habitat with Phayre's langur (*T. phayrei*), capped langur (*T. pileatus*), rhesus macaque (*Macaca mulatta*), pig-tailed macaque (*M. nemestrina*), and slow loris (*Nycticebus coucang*) (Gupta 1996).

The golden langur is little studied for its distribution status, population estimates, ecology and behaviour. A brief study on its ecology and behaviour was done by Saha and Mukherjee (1974). In this study, a part of the project on Conservation Ecology of Primates and Human Impact in northeast India, a detailed study of the ecology and behaviour of one group of the golden langur and its survival, vis-à-vis other primate species in the study area, especially with reference to two sympatric langur species, has been worked out.

Study Area

The study was conducted in Sepahijala Wildlife Sanctuary (18.53 sq. km), West Tripura, northeast India (Fig. 1). It is located about 35 km south of the capital Agartala and receives an annual rainfall of about 2,000 mm. The mean maximum temperature is 36 °C and mean minimum temperature is 22 °C.

The sanctuary is a small island surrounded by human habitation and agricultural fields. In the past, evergreen forests occupied a large portion of the sanctuary, but following large-scale deforestation, due to human and livestock pressure from 17 adjoining villages, these evergreen forests now exist as scattered degraded patches surrounded by plantations of timber, cash-crops or fast growing exotic species. Some of the oldest plantations in the area (about 50 years old) are those of major timber species such as *Tectona grandis*, *Gmelina arborea*, *Shorea*

robusta, *Dipterocarpus turbinatus,* and *Albizzia procera*.

Methods

Study animal

Khajuria (1960) described the golden langur, and its taxonomy was discussed by Oboussier and Maydell (1959) and Khajuria (1960). This langur is placed with Phayre's and capped langurs in the conservation priority ratings (Endey, 1987), in Schedule I in the Wildlife (Protection) Act, 1972.

Ecological data collection and analysis

After a period of three months, during which the study group of golden langur was habituated and the study area mapped, intensive ecological studies started in December 1993. The group was followed for two consecutive days each month, due to time constraints, from dawn to dusk for an annual cycle of 12 months. Time spent on different activities was estimated by group scans (Altmann 1974). A 'scan' refers to a single recording of the behaviour of an individual within 15 minute intervals, which provided data on feeding. Feeding includes handling, chewing, and ingesting of a food item. Food items were classified as leaf buds, young and mature leaves, flower buds and flowers, unripe and ripe fruit, seeds, and twigs. Whenever possible, food plants were identified. The animal food consumed by the study group was also identified.

Raemaekers and Chivers (1980) have suggested that in a variable and complex forest environment, continual monitoring and frequent sampling of primate groups from dawn to dusk on at least 5, preferably 8-10 consecutive days, is important for assessing the behavioural and ecological repertoire of any primate group. But since the main aim of this study was to collect data on the use of food resources, which were also used by two other sympatric langur species and resident human population, a 2-day observation period could prove sufficient. The data collected from dawn to dusk for 2 continuous days and notes (during surveys, vegetation samplings, phenological studies) provided the first ever systematic data on the behavioural ecology of golden langur, covering all the cyclical changes in vegetation and environmental parameters over a year. Curtin (1980), in an almost similar situation, used alternating periods of 2-3 day dawn-to-dusk observation periods each month for studying the ecology and behaviour of two sympatric species (*Presbytis melalophos* and *Trachypithecus obscurus*).

The percent feeding time during the day was calculated from:

Tf = (nf x 100)/N, where

Tf — % daytime spent on feeding,

nf — number of feeding records and,

N — total number of activity records for the day.

Feeding time on different plant species and parts, as well as animal diets, was also estimated using the above equation (Gupta and Kumar 1994).

Spearman rank-order correlation coefficients were used to analyse the relationships between diet and phenology. The preference index (PI) was calculated for each food species in relation to its abundance in the study area: one divides percentage feeding time on a given species by its relative abundance, calculated as the percentage of total basal area (Kumar 1987). Monthly dietary diversity was calculated using Shannon-Wiener index of diversity (H') (Pielou 1966), using both plant species and parts in the analysis.

Vegetation data collection and analysis

Four plots were established within the study area and 1,090 trees of 112 species, selecting at least 5 trees of more than 20 cm girth at breast height (gbh) from each species. The trees were numbered and measured for their height, gbh, crown width, and crown density.

Each plot was monitored once a month on a predetermined date. It took 2 to 3 days to visit all marked trees over an area of about 60 hectares. Each marked tree was visually scanned for different plant parts: leaf buds, young leaves, mature leaves, flower buds, flowers, unripe fruit, ripe fruit, and seeds. The abundance of a given plant part was recorded as the proportion of total canopy volume using a 0 to 3 scale, referring to the value 0%, 1-10%, 11-50%, and more than 50% respectively (Raemaekers 1977, Bennett 1983, Hardy 1988). Additional information on study animals, study site, and general methods is available in Gupta (1996).

Results

Group Size and Composition

At the beginning of this study in December 1993, there was one group of 7 golden langurs (1 adult male, 3 adult females and 3 infants). In January 1994, one infant was born, but it did not survive. In July, one adult male escaped from the neighbouring Sepahijala Zoo and joined the group. In the same month, it formed a separate group with one adult female from the original group and occupied a different area within SWLS. Observations were continued on the original group, which now consisted of 6 individuals. This group shared the habitat with 17 groups of *T. phayrei*, 18 of *T. pileatus*, 11 of *Macaca nemestrina*, about 37 of *M. mulatta* and 3 groups of *Nycticebus coucang*.

Activity Patterns

A total of 7,752 scans were made on the study group, representing about 304 hours of observations over 24 full days in 12 months with an average of about 646 (sd = 94) scans/month. Feeding accounted for 45.5 % (n = 3,530) of the daytime, followed by resting (26.7%, n = 2,071) and travel (9.5 %, n = 737). Other activities like grooming and play accounted for 18.3% (n = 1,414) (Fig. 2).

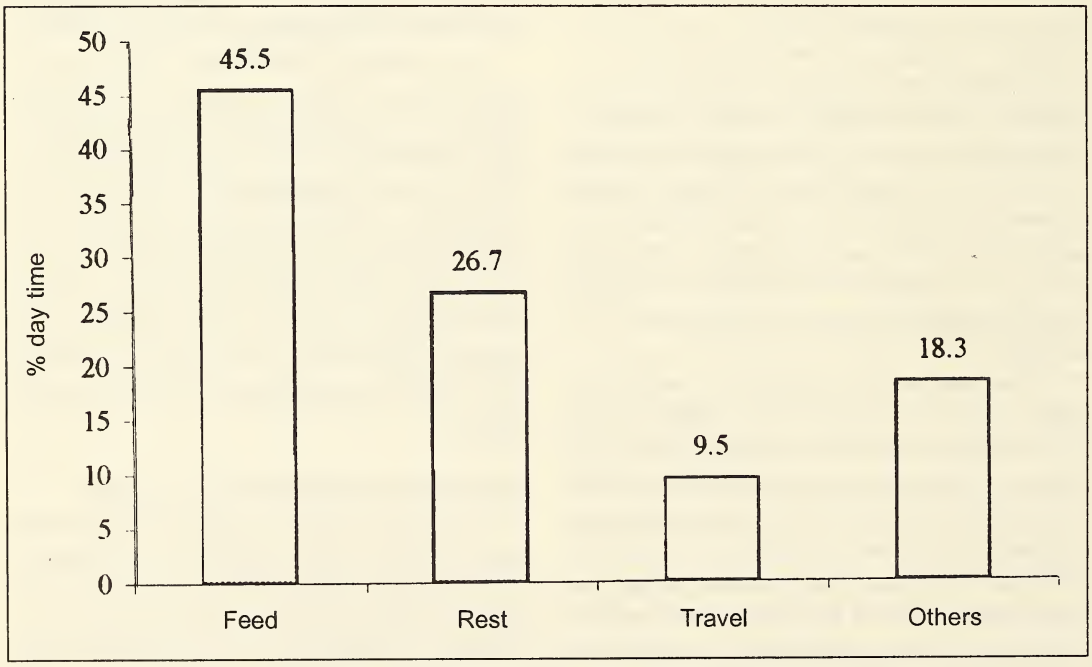

Fig. 2: Time spent (%) in different activities (N=7752)

Feeding

Feeding normally started around 0430 hrs in summer and 0530 hrs in winter. The langurs had two feeding peaks during their 12 to 13 hours of activity in any given day, one peak just after waking up (between 0630 and 0800 hrs), and the second peak in the late afternoon just before roosting (between 1530 and 1700 hrs).

Daily, monthly, and seasonal variations in feeding time

The daily feeding time ranged between 30% (December) and 64.9% (November) (mean = 45.5, sd = 10.1, CV = 22.2%).

A very weak significant difference was found in the feeding time in different months (K-W 1-way Anova, $p > 0.09$), which varied between 36% and 62.6% (mean = 45.6%, sd = 9.4, CV = 20.6%). Most feeding was observed in November (62.6%) and the least in December (36%) (Fig. 3).

The variation in feeding time by the golden langur was not marked when the months were grouped into three seasons: winter (Nov. through Feb.), summer (Mar. through May), and monsoon (Jun. through Oct.). There was no significant difference between the seasons in feeding time (K-W 1-way Anova, $p = 0.22$) in monsoon months being 49.9%, and in winter months 45.6%. The feeding time in summer months (39.8%) was only weakly significantly different from monsoon months (Mann-Whitney U-Wilcoxon Rank Test, $p = 0.07$), but not significantly different from winter months (Mann-Whitney U-Wilcoxon Rank Test, $p = 0.49$). There was no significant difference in the feeding time between winter and monsoon months (Mann-Whitney U-Wilcoxon Rank Test, $p = 0.51$).

Use of food plant species

A total of 53 plant species were used during the annual feeding cycle by the golden langur. Of these, 45 (84.9%) were trees, 2 (3.8%) shrubs, and 6 (11.3%) were climbers. Of all the food plant species, the majority (N = 42, 79.2%) provided only one type of food item at any given time, while the remaining eleven species (20.8%) provided more than one type of food items at any given time (Table 1).

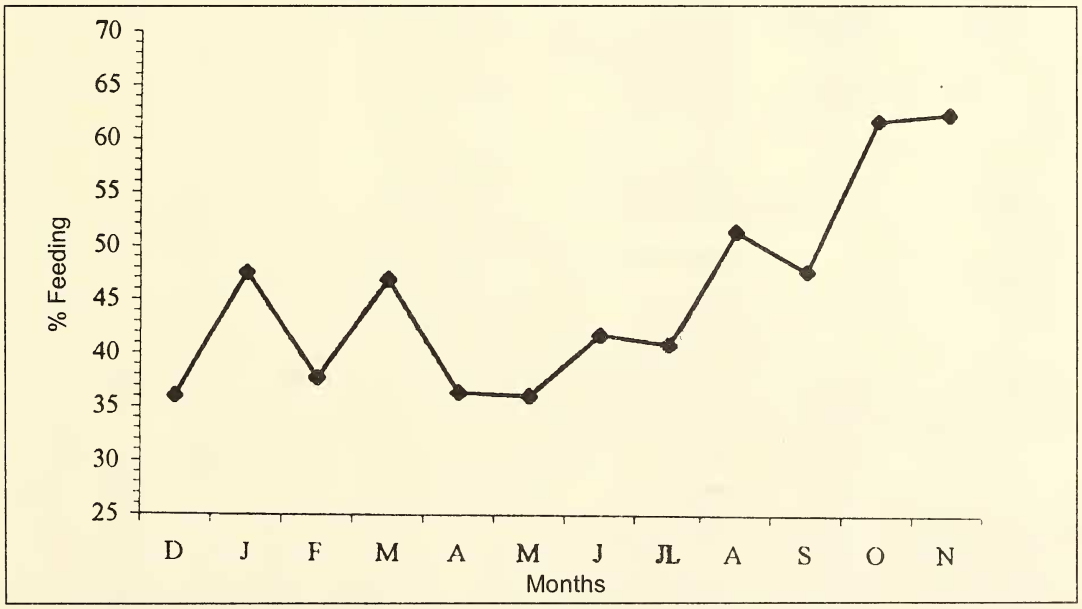

Fig. 3: Monthly variation in time spent feeding by golden langur

TABLE 1
FOOD PLANTS OF THE GOLDEN LANGUR IN SEPAHIJALA WILDLIFE SANCTUARY

Species	Common names	Family	Feeding (N)	% of Total	Parts eaten	E/N	P/NP	FORM
Odina wodier	Kaimala	Anacardiaceae	100	2.8	fb, fl	N	NP	T
Polyalthia longifolia	Deodaru	Annonaceae	3	0.1	yl, ml	N	NP	T
Mikania cordata	Mikania	Asteraceae	208	5.9	yl, fl	E	NP	C
Stereospermum personatum	Soya awal	Bignoniaceae	43	1.2	yl	N	P	T
Salmalia malabarica	Simul	Bombacaceae	122	3.5	yl, fl	N	P	T
Bursera serrata	Neur	Burseraceae	25	0.7	yl	N	P	T
Caesalpinia pulcherrima	Radhachura	Caesalpiniaceae	55	1.6	yl	E	P	T
Delonix regia	Krishnachura	Caesalpiniaceae	430	12.2	yl, fl, s	N	NP	T
Bauhinia malabarica	Kanchan	Caesalpiniaceae	36	1.0	yl	N	NP	T
Terminalia bellirica	Bahera	Combretaceae	64	1.8	urf, twig	N	P	T
Anogeissus acuminata	Kailodi	Combretaceae	32	0.9	pt, yl	N	NP	T
Dillenia indica	Chalta	Dilleniaceae	40	1.1	ml	N	P	T
Dillenia pentagyna	Hargaza	Dilleniaceae	26	0.7	fb, fl	N	NP	T
Dioscorea alata	Maiya-alu	Dioscoreaceae	6	0.2	yl	E	P	C
Pterocarpus dalbergioides	Andaman padauk	Dipterocarpaceae	63	1.8	yl	E	P	T
Mallotus philippensis	Sinduri	Euphorbiaceae	55	1.6	pt, urf	N	P	T
Castanopsis tribuloides	Kanta gach	Fagaceae	17	0.5	s	N	NP	T
Garcinia cowa	Kao	Guttiferae	87	2.5	lml	N	NP	T
Mesua ferrea	Nageshwar	Guttiferae	5	0.1	s	N	P	T
Litsea glutinosa	Kakra	Lauraceae	17	0.5	fb, fl	N	NP	T
Michelia champaca	Champa	Magnoliaceae	9	0.3	yl	N	NP	T
Hibiscus rosa-chinensis	Gurhal	Malvaceae	1	0.0	yl	N	P	S
Acacia auriculiformis	Acacia	Mimosaceae	331	9.4	s	E	P	T
Adenanthera pavonina	Raktanchan	Mimosaceae	123	3.5	yl	E	P	T
Leucaena leucocephala	Kupa	Mimosaceae	98	2.8	yl	E	P	T
Artocarpus chaplasha	Chamal	Moraceae	183	5.2	rf	N	P	T
Ficus racemosa	Vat	Moraceae	174	4.9	ml	N	NP	T
Ficus hispida	Dumbur	Moraceae	125	3.5	urf	N	NP	T
Ficus spp.	Loijuri	Moraceae	71	2.0	urf	N	NP	T
Artocarpus lakoocha	Dewa chamal	Moraceae	61	1.7	rf	N	P	T
**Ficus glomerata*	Jogya dumber	Moraceae	35	1.0	urf	N	NP	T
Ficus religiosa	Pipal	Moraceae	32	0.9	yl	N	NP	T
Syzygium fruticosum	Ban jam	Myrtaceae	46	1.3	sl, yl	N	NP	T
Dalbergia lanceolata	Bhat koroi	Papilionaceae	49	1.4	yl	N	P	T
Ziziphus rugosa	Ban boroi	Rhamnaceae	7	0.2	urf	N	NP	T
Gardenia turgida	Gandhraj	Rubiaceae	11	0.3	fb	E	NP	T

* *Ficus glomerata* is treated as a sub-species of *F. racemosa*

TABLE 1 (*contd*)
FOOD PLANTS OF THE GOLDEN LANGUR IN SEPAHIJALA WILDLIFE SANCTUARY

Species	Common names	Family	Feeding (N)	% of Total	Parts eaten	E/N	P/NP	FORM
Anthocephalus cadamba	Kadam	Rubiaceae	8	0.2	yl	N	P	T
Pterospermum semisagittatum	Banduri	Sterculiaceae	11	0.3	bark	N	NP	T
Aquilaria agallocha	Agar	Thymeliaceae	21	0.6	yl	N	P	T
Microcos paniculata	Pichla	Tiliaceae	28	0.8	rf	N	NP	T
Trema orientalis	Banalya	Ulmaceae	113	3.2	yl	N	NP	T
Trema spp.	Lal banalya	Ulmaceae	8	0.2	ml, lml	N	NP	T
Unidentified	Phul gamar	Unidentified	6	0.2	yl	N	NP	T
Gmelina arborea	Gamar	Verbenaceae	144	4.1	yl	N	P	T
Nyctanthes arbortristis	Rat-ki-rani	Verbenaceae	3	0.1	s, fl	N	P	T
Unidentified climber 4	UIC-4		174	4.9	s	N	NP	C
Unidentified climber 3	UIC-3		112	3.2	fb,fl	N	NP	C
Unidentified climber 1	UIC-1		41	1.2	yl	N	NP	C
Unidentified tree 1	UIT-1		38	1.1	urf	N	NP	T
Unidentified climber 2	UIC-2		14	0.4	s	N	NP	C
Unidentified tree 4	UIT-4		14	0.4	yl	N	NP	T
Unidentified tree 2	UIT-2		3	0.1	yl	N	NP	T
Unidentified tree 3	UIT-3		2	0.1	fb, fl	N	NP	T

sl = sprouting leaf, yl = young leaf, ml = mature leaf, fb = flower buds, fl = flowers, pt = petiole, lml = lamina, s = seeds urf = unripe fruit, rf = ripe fruit.

N = native, E = exotic, P = plantation species, NP = non-plantation species, UN = unknown

Form: T = tree, S = shrub, C = climber

Out of 53 food species, 44 species belonged to 28 families and 9 species could not be identified (Table 1). Leguminosae and Moraceae families accounted for more than half (51.1%) of the total feeding time. Similar to capped langur, the food plants belonging to Leguminosae (together with Mimosaceae, Caesalpiniaceae, and Papilionaceae) were used most (31.8%), followed by Moraceae (19.3%). Eight families (Anacardiaceae, Asteraceae, Bombacaceae, Combretaceae, Dilleniaceae, Guttiferae, Ulmaceae and Verbenaceae) together accounted for about 27% of the total feeding time. The remaining 18 identified and 9 unidentified families accounted for 22% of the total feeding time (Fig. 4). The number of food species belonging to these ten major families varied from 1 (Asteraceae, Anacardiaceae, and Bombacaceae) to 7 (Moraceae and Leguminosae).

Daily, monthly, and seasonal variation in plant species use

The number of food plant species used in each full-day observation was consistent, ranging from 3 to 14 (mean = 9, sd = 2.8). The number of plant species used each month varied from 7 to 18 (mean = 13.5, sd = 3.2), but these variations were very weakly significant (K-W 1-way Anova, p = 0.1). The maximum number of food species were used in April (n = 18), and the least in June (n = 7). The total number of plant food species used in three seasons varied between 28 and 42 (mean = 31.6, sd = 3.8).

Use of plant food species between seasons also did not vary significantly (K-W 1-way Anova, p>0.1), and was marginally higher in monsoon (64.2%), than in winter (62.3%) and summer (52.8%).

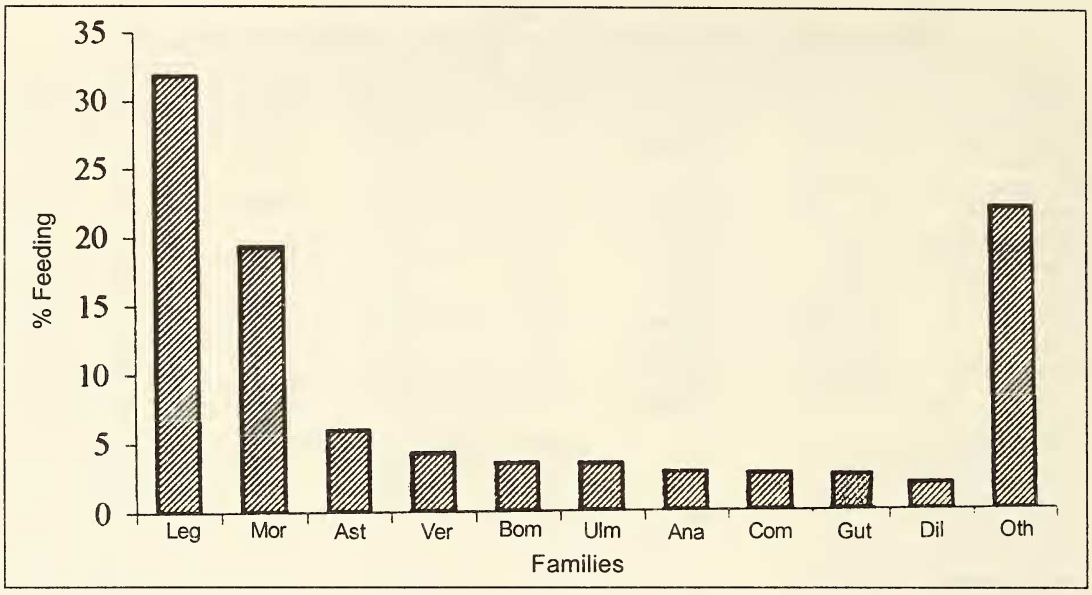

Fig. 4: Time spent feeding on major food plant families and number of species in each family by the golden langur in Tripura

Use of native and exotic plant species

Out of a total of 53 food species, 45 (84.9%), were native plant species (including 9 unidentified species of doubtful identification), and only 8 (15.1 %) were exotic. Unlike the capped langur, the time spent on native food species was higher (74.7%, n = 2,635) than on exotic species (25.3%, n = 895).

Use of plantation and non-plantation species

Twenty-three (43.4%) food species used by golden langur in their annual diet were the common forestry plantation species and the remaining 30 (56.6%), including all 9 unidentified species, were the non-plantation species in the study area. The feeding time on plantation species was slightly less (43.5%, n = 1,536) than on non-plantation species (56.5%, n = 1,994).

Top ten food species

Based on their contribution to the annual diet of golden langurs, the top ten species (*Mikania cordata*, *Acacia auriculiformis*, *Adenanthera pavonina*, *Ficus hispida*, *Delonix regia*, *Salmalia malabarica*, *Ficus racemosa*, *Artocarpus chaplasha*, *Gmelina arborea* and an unidentified climber), accounted for about 57% (n = 2,014) of total feeding time. The monthly feeding time on these species was consistent, and ranged from 20.8% to 85.3% (mean = 55, sd = 18.5, CV = 33.6%). The total number of top ten food species contributing to the diet in any one month varied from a minimum 3 (January, March, and June) to a maximum of 6 (December and July) species. In 9 out of 12 months, these species accounted for more than 50% of the total feeding time on all the species in any given month.

In March and June, only one of the top ten species, the unidentified climber and *Artocarpus chaplasha* respectively, accounted for more 55.8% and 55.2% of the total feeding time. Among the top ten food species, only one species, an unidentified climber, was foraged in one month (March) only, but the remaining 9

TABLE 2
FEEDING TIME (%) ON TOP TEN FOOD SPECIES BY THE GOLDEN LANGUR IN SEPAHIJALA WILDLIFE SANCTUARY

Month	Feeding on top ten species (%)										Total (%)
	AA	DR	MC	SM	FR	FH	AP	UIC	AC	GA	
December 1993	15.0	6.1	11.3	0.8	7.3	12.1	0.0	0.0	0.0	0.0	52.6
January 1994	31.3	0.0	2.3	0.0	17.5	0.0	0.0	0.0	0.0	0.0	51.2
February	3.5	0.0	0.0	0.0	8.3	21.7	0.4	0.0	0.0	0.0	33.9
March	0.0	0.0	0.0	0.0	9.9	2.9	0.0	55.8	0.0	0.0	68 6
April	3.0	5.7	0.0	0.0	4.9	0.0	7.2	0.0	0.0	0.0	20.8
May	1.4	19.4	0.0	0.0	22.3	0.0	9.4	0.0	0.0	0.0	52.5
June	0.0	0.0	0.3	2.3	0.0	0.0	0.0	0.0	5.2	0.0	57.7
July	0.0	8.0	6.2	14.6	0.0	5.8	6.6	0.0	0.0	18.2	59.5
August	0.3	44.9	13.5	0.0	0.0	0.0	2.1	0.0	0.0	4.5	65.3
September	0.0	13.8	5.4	12.1	0.0	0.0	0.0	0.0	1.0	3.4	35.6
October	23.0	26.6	18.9	0.0	0.0	3.9	9.8	0.0	0.0	3.1	85.3
November	21.2	15.5	5.4	10.1	0.0	0.0	7.3	0.0	2.4	15.5	77.4
N	331	430	208	122	174	125	123	174	183	144	2014
%	9.4	12.2	5.9	3.5	4.9	3.5	3.5	4.9	5.2	4.1	57.1
Sd	8.2	11.7	5.3	3.3	5.9	3.9	3.6	4.6	4.9	3.7	55.0
CV(%)	11.3	13.6	6.3	5.5	7.6	6.7	4.1	16.1	15.9	6.4	18.5

AA = *Acacia auriculiformis*, DR = *Delonix regia*, MC = *Mikania cordata*, FR = *Ficus racemosa*, FH = *Ficus hispida*, AP = *Adenanthera pavonina*, UIC = Unidentified climber, AC = *Artocarpus chaplasha*, GA = *Gmelina arborea*

species were foraged during 3 to 8 months (Table 2). *Delonix regia* and *Adenanthera pavonina* were fed upon most (12.2%) and least (3.5%), among all top ten-food species.

Preference Indices

Of these top ten species, 8 were represented in the 12 vegetation transects (*Mikania cordata* and one unidentified climber were excluded from the analysis). Preference indices for each of the 8 (top ten) food species were calculated, based on their relative abundance within the study area, and proportion of total feeding time on the given species. *Gmelina arborea* had the highest preference index (PI) value of 31.5, followed by *Delonix regia* (21.4). Similar to capped langur, *Acacia auriculiformis* was lowest in its PI value (1.2), although feeding time on this species was second (9.4%) only to *Delonix regia* (12.2%). *Ficus racemosa*, *Salmalia malabarica* and *Adenanthera pavonina* were less abundant in the study area, but were highly preferred as food species with relatively high PI values: 10, 6.1, and 5.8 respectively. *Artocarpus chaplasha* was the second most abundant species in the study area, after *Acacia auriculiformis*, but unlike the latter species, *Artocarpus chaplasha* was also highly preferred as food (PI = 8.7) (Table 3).

Out of these top ten food species, three were exotic, accounting for 18.8% of the total feeding time on all species, while 7 were native, accounting for 38.3% of the total feeding time (Table 3).

Five of the top ten species were forestry plantation species in the study area, and accounted for 25.6% of the total feeding time, while the remaining 5 were non-plantation species, accounting for 31.5% of the total feeding time on all species (Table 3).

Six of the top ten species, namely, *Acacia auriculiformis*, *Mikania cordata*, *Delonix regia*, *Ficus racemosa*, *F. hispida*, and *Artocarpus chaplasha* were also among the top ten species used by Phayre's langur. Golden langur shared

TABLE 3
PREFERENCE INDICES OF TOP TEN FOOD SPECIES USED BY GOLDEN LANGUR IN SEPAHIJALA WILDLIFE SANCTUARY, TRIPURA

Species	% Abundance	Feeding		PI	Status	Form
		N	%			
Acacia auriculiformis	8.1	331	9.4	1.2	E	P
Delonix regia	0.6	430	12.2	21.4	N	NP
Salmalia malabarica	0.6	122	5.9	6.1	N	P
Ficus racemosa	0.5	174	5.0	10.0	N	NP
Ficus hispida	2.2	125	3.6	1.6	N	NP
Adenanthera pavonina	0.6	123	3.5	5.8	E	P
Artocarpus chaplasha	6.6	183	5.2	8.7	N	P
Gmelina arborea	0.1	144	1.4	31.5	N	P
Mikania cordata	Not known	208	5.9	-	E	NP
Unidentified climber	Not known	174	5.0	-	N	NP

E = exotic, N = native, P = plantation species, NP = non-plantations species

only five of the top-ten food species (*Acacia auriculiformis*, *Adenanthera pavonina*, *Mikania cordata*, *Delonix regia*, and *Ficus hispida*) with capped langurs in the study area.

Food species used by Phayre's and capped langur groups

Of the 53 food species used by golden langurs 30 (56.6%) were used by the Phayre's langur, while the remaining 23 species (43.4%), were exclusively fed by the golden langur. These common food species accounted for 76.4% of the total feeding time by golden langur and about 67% by Phayre's langur group.

Only 26 (49.1%) food species, out of a total of 53 used by the golden langur, were common with the capped langur. These 26 species accounted for about 75% of the total feeding time on all the food species by golden langur, while their contribution to the feeding time of the capped langur was about 70%.

Food species also used by the local human population

Of the 53 food species used by golden langurs, 23 (43.4%) were also used by the local human population for fuelwood, fodder, small construction timber, timber, food, and so on. The contribution of these 23 species in the annual diet of golden langur was about 48.1 % (n = 1,703).

Use of plant parts

Golden langurs spent most time feeding on young leaves (41.4%), followed by seeds (25.7%), unripe fruit (11.1 %), ripe fruit (10.1%), flowers (9%), mature leaves (2.4%), and others (0. 3 %) (Fig. 5).

The consumption of young leaves was consistently high through all the months compared with other plant parts. Feeding on young leaves was least in March (17.6%) and highest in July (60%). The monthly variation in feeding time was also least for young leaves (CV = 37.9%). There was no significant monthly difference in feeding time on any of the different plant parts.

Only young leaves were eaten in all the 12 months, followed by seeds for 11 months (except in June), and flowers for 9 months. The use of other plant parts ranged between 3 and 6 months.

Time spent eating only flowers was highly significant (K-W 1-way Anova, p = 0.004). However, when the monthly data were pooled into three seasons, time spent feeding on flowers was not significant. Seasonal variation in feeding

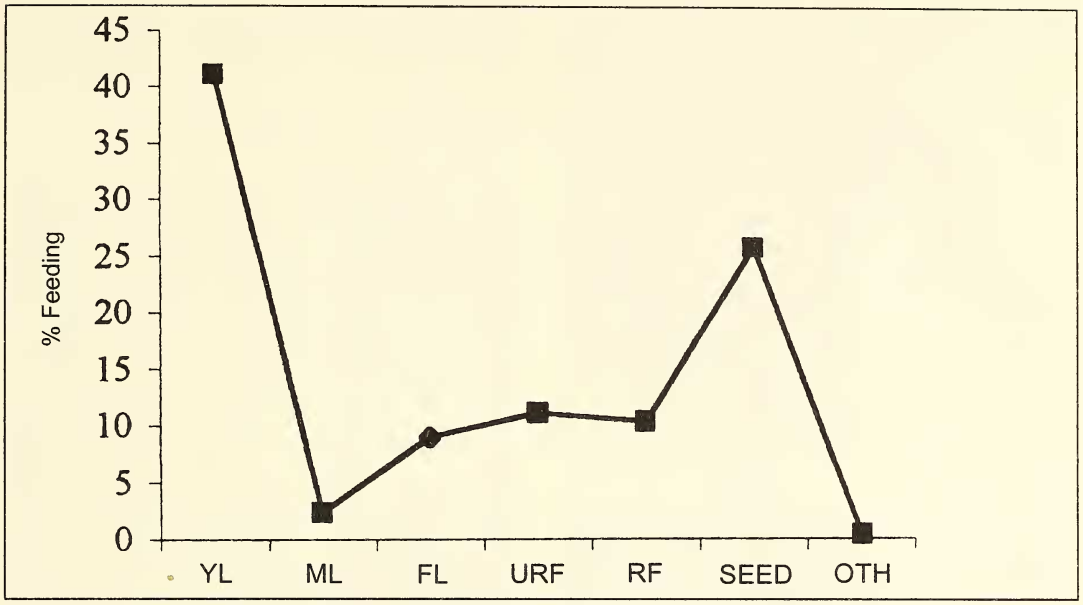

Fig. 5: Time spent feeding on different plant parts by golden langur in Tripura

time on other plant parts was not significant.

Of the 53 food species used by the golden langur group, 40 (75.5%) were for young leaves, followed by 14 (26.4%) for flowers, 10 (18.9%) each for unripe fruit and seeds, 8 (15.1%) for ripe fruits, 3 (5.7%) for mature leaves, and only one (1.9%) for other plant parts (Fig. 6). The total number of species taken in any one month for different plant parts also varied. For the consumption of young leaves, it ranged between 6 and 12 species, but for other plant parts between 1 and 4 only, which was consistent across the months, with most of the food plant species being used for young leaves, and very few for other plant parts

Dillenia indica, *Garcinia cowa* and *Trema* spp. were the three main species used for feeding on mature leaves. One unidentified climber (UIC3) and *Delonix regia* were two main species for flowers. Several species of *Ficus* and unripe pods of many Leguminosae were the main source of unripe fruit. Both *Artocarpus chaplasha* and *A. lakoocha* were the major sources of ripe fruit, besides *Dillenia pentagyna*. *Acacia auriculiformis*, *Delonix regia* and *Adenanthera pavonina* were the major source of seeds in the annual diet of the golden langur group.

Availability of plant parts

The monthly variation in the availability of young and mature leaves, ripe and unripe fruit and seeds are given in Fig. 7. Young leaves, which the group fed on extensively each month, were available for many food plants throughout the year. The food species with young leaves were scarce in the dry months (November through February), when fruit and seeds were abundant. No correlation was found between the feeding time on young leaves in each month and with the number of species with young leaves (Spearman rank correlation coefficient $r_s = 0.14$, $p = 0.67$).

Mature leaves were available mostly during the late monsoon and in winter months, but feeding on mature leaves was only weakly negatively correlated ($r_s = -0.33$, $p = 0.29$) with

their availability. This was because the langurs used only three species (*Dillenia indica*, *Garcinia cowa*, and *Trema* spp.), and the feeding time was dependent on the availability of mature leaves on these three species, irrespective of the availability from other species.

Negative non-significant correlation was found between the feeding time on unripe fruits and seeds and the number of species with these plant parts (r_s = 0.35, p = 0.25; and r_s = 0.33, p = 0.28, respectively). The reason for this is also the dependence of langurs for these food items on only 1 to 3 plant species, irrespective of the availability of these plant parts on other species.

Ripe fruits of *Artocarpus chaplasha* and *A. lakoocha* were available only during the dry months (November through February), but more than 70% of the total feeding time on ripe fruit was only in one month, i.e. June. Therefore, no correlation was found between the availability and feeding time on ripe fruit (r_s = 0.03, p = 0.90).

Discussion

Golden langurs are primarily folivorous, but were able to switch over to a fruit and seed diet when foliage was scarce. Most of the food species were used for young foliage. Other plant parts were consumed from a few food species, most of which were common with the Phayre's and capped langur (*Acacia auriculiformis*, *Adenanthera pavonina*, *Delonix regia*, for seeds, and *D. pentagyna*, *Artocarpus lakoocha*, and *A. chaplasha* for ripe fruit). Although golden langur shared the habitat with two other species, there was some resource partitioning by the use of different food species for specific food items. The primary source for mature leaves (*D. indica*, *Garcinia cowa*) for golden langurs differed from

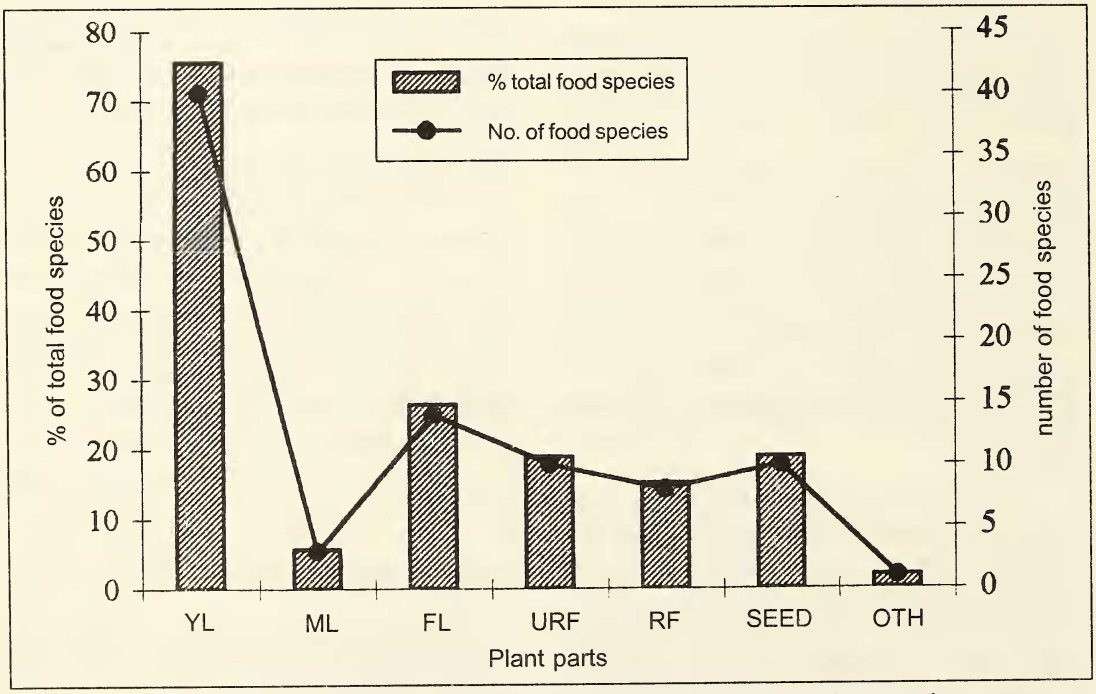

Fig. 6: Number and % of food species used for feeding on different plant parts by the golden langur in Tripura

Phayre's (*Ficus racemosa*) and capped langurs (*Ailanthus integrifolia*, *Pterocarpus dalbergioides*). While several species of *Ficus* were used by golden langurs as primary sources for unripe fruit, other langurs used two species of *Ficus* and *Artocarpus chaplasha* (Phayre's langur) and *Artocarpus heterophyllus* (capped langur). Although primary food sources for ripe fruit and seeds were the same in all three species (*D. pentagyna* for ripe fruit; *A. auriculiformis*, *A. pavonina*, *D. regia* for seeds), on most occasions the three langur species visited the same food patches at different times. Inter-group relations with capped and Phayre's langur were always relaxed, as on occasions the groups shared food trees, approaching within 5 to 10 m of each other, and infants mixing and playing with each other. The tendency of golden langurs to feed on the ground and very close to human habitation also helped them use resources that were not available to the other two sympatric species.

In the use of food plants, golden langurs shared species with Phayre's and capped langurs and the local people. As in Phayre's and capped langur, most of the preferred food species for golden langurs were exotic fast growing plantation species from Leguminosae and Moraceae families.

The ability of golden langurs to survive on a few fast growing exotic plantation species could be used as a main management tool to increasing the existing resource base through plantation of such species. This is likely to benefit other different user groups (local human populations and other wildlife species sharing the habitat), besides the golden langur.

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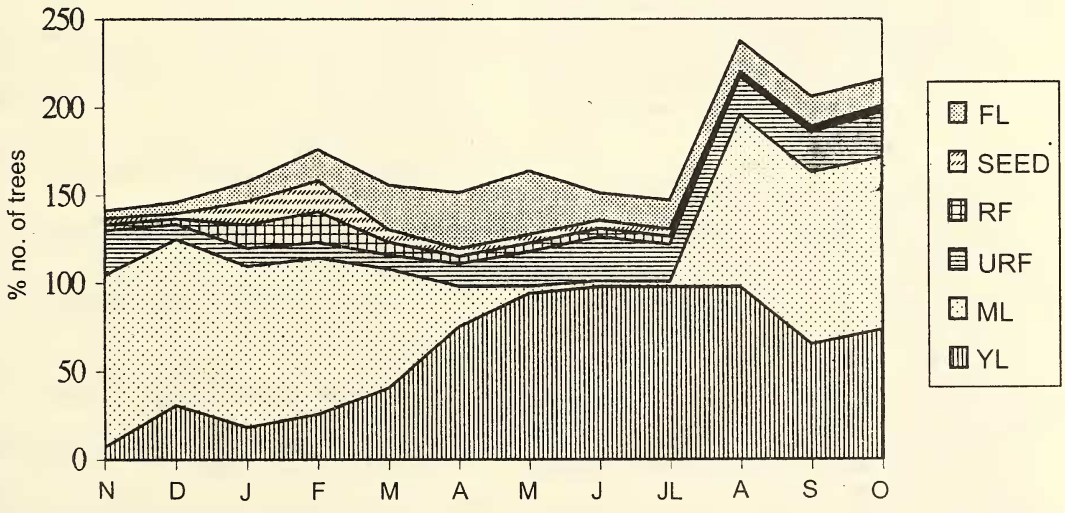

Fig. 7: Monthly variations in the availability of plant parts

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